Research on environmental protection and water and soil conservation technology of power grid engineering mechanized construction based on modular design

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Abstract. In the construction and development of modern society, power grid engineering as an important content of urban construction and development and protection of residents' quality of life, in the face of the expanding scale of power grid investment, power grid project construction shows a rapid growth trend. With the continuous development of social economy and smart grid construction needs, the requirements of power grid construction quality and construction period are getting higher and higher. On the basis of understanding the research status of mechanized construction of power engineering, this paper mainly discusses the principle and structure of modular design by taking the actual soil and water conservation measures on site as an example, and then takes the mechanized construction of power engineering in a certain area as an example to determine the construction environmental protection technology, in order to improve the comprehensive level of China's power grid construction.

Keywords: modularity; Design idea; Power grid engineering; Mechanization; Environmental protection; Soil and water conservation.

1. Introducion

China is currently in the stage of large-scale urban development and infrastructure construction, with the acceleration of industrialization, urbanization, agricultural modernization, transportation, energy, urban construction and other infrastructure construction scale will remain at a high level, development and construction caused by soil erosion control pressure is still prominent, the task of supervision is arduous. In recent years, the development pace of the State grid in the central region has accelerated, among which the Hunan power grid will basically build a strong smart grid with UHV as the backbone grid and coordinated development of power grids at all levels. Vigorously promoting mechanized construction is an inevitable choice to improve the efficiency of power grid construction. Compared with traditional conventional construction methods, fully mechanized construction can reduce labor costs, improve construction efficiency, and enhance construction safety. However, mechanized construction causes severe disturbance to the surface, and large mechanical equipment entering and leaving the site for foundation excavation, backfill, temporary soil piling and other construction activities will expand the surface vegetation area of the disturbed area. It is more likely to change the geological geomorphology and soil structure of the disturbed area, thereby reducing the soil and water conservation function of the original surface of the disturbed area and increasing the amount of soil and water loss in the region. [1-5]

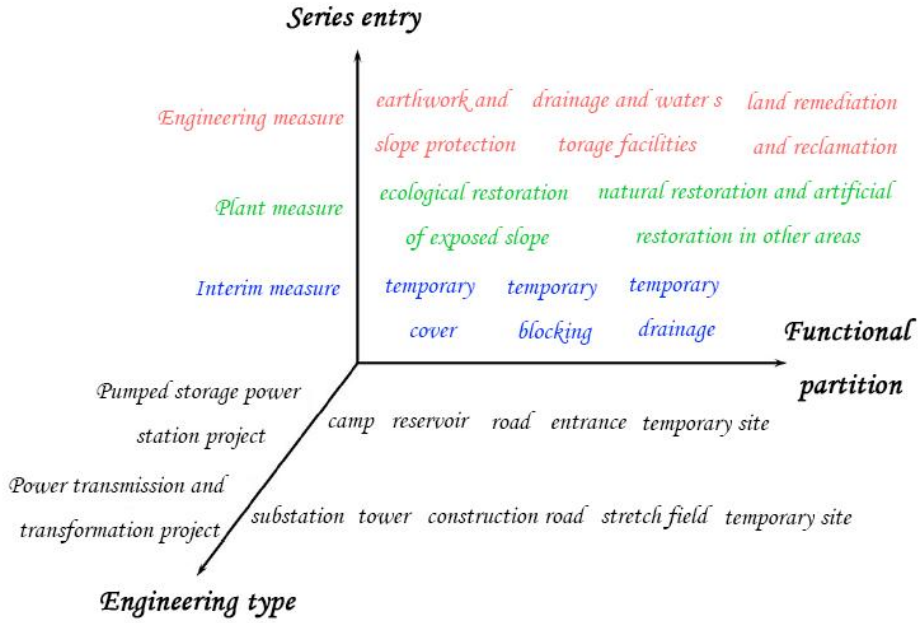

FIG. 1 Grid engineering ecological restoration measures system diagram

At present, the mechanized construction of power grid engineering has not established corresponding or targeted environmental protection standards, technical specifications and measures, and mechanized construction is very easy to cause common problems such as overboundary disturbance, site selection deviation, road slope slag, improper disposal of residual soil, and inadequate vegetation restoration. Therefore, prevention and control measures should be carried out in advance for environmental protection and water protection problems that may occur or cause in the process of mechanized construction, and corresponding solutions and treatment measures should be taken in time for areas with environmental protection problems, and a system of measures from "prevention" to "treatment" should be carried out in combination with the influencing factors such as topography, soil conditions and climate conditions in Hunan Province. The formation of supporting standards, technical specifications and measures to guide the implementation of environmental protection and water conservation measures in the whole process of mechanized construction, and improve the scientific and systematic comprehensive control of soil and water loss in the whole process of mechanized construction.［6-8］

2. Method

2.1 Analysis of the main direction of prevention and control of construction disturbance

Combined with the actual requirements of the engineering environmental water protection process management and acceptance objectives, the construction disturbance prevention and control of Yancheng-Chenzhou East 500kV line project is mainly carried out from the following three aspects of the construction of the construction base area and the construction road area:

(1) Construction disturbance range control

Sometimes, in order to facilitate the stacking of materials and parking of vehicles and machinery in the construction process, the construction unit will expand the temporary construction area in the base area; In addition, in the current background of vigorously promoting mechanized construction, the selection of construction roads is particularly important, and sometimes in order to facilitate mechanical passage, the construction of temporary roads will be widened or diverted to extend,

which virtually increases the scope of soil erosion prevention and control responsibility of the project. Therefore, the primary goal of construction disturbance prevention and control is to select the optimal road that meets the conditions of construction machinery and equipment passage and material transportation by combining the topographic elevation data of the landform where the tower is located, that is, the shortest length, the narrowest width and the smallest turning radius. In the base area, the construction area layout is reasonably planned to meet the requirements of construction platform, vehicle equipment parking, tower material placement, and separate stacking of topsoil/residual soil, so as to achieve the effect of control of the disturbance range of engineering construction.

(2) Implementation of environmental protection measures

At present, according to the relevant requirements of the water conservation scheme of the project, the total amount of soil and water conservation measures such as engineering measures, plant measures and interim measures will be required for a certain section of the project, and the environmental protection measures in the EIA report rarely involve the relevant requirements during the construction period. In this case, for the relevant operators of the construction unit, it is difficult to reach the depth of on-site construction guidance. Based on this, the second objective of construction disturbance prevention and control is to analyze the topography, geomorphology and soil conditions of the engineering base area and the construction road area, and specify the detailed quantification of the engineering measures such as slag retaining wall and drainage ditch that need to be set on the tower legs in the tower base area, and give the specific engineering quantity of the construction unit. According to the construction time sequence, the stage acceptance standard of the construction transition is reasonably planned, and the completion rate and compliance rate of soil and water conservation plant measures are improved from the perspective of regional stage restoration. And then improve the feasibility and standardization of the implementation of environmental protection measures in the construction base area and the construction road area.

(3) Standard stacking and disposal of topsoil/residual soil

The disturbed area of excavation and backfill in the construction base area and the construction road area is large, and the construction unit lacks construction standards and experience in topsoil stripping and storage and disposal and transportation of residual soil, and the topsoil is not stripped in place or improperly stacked after stripping, resulting in the lack of mature soil in the construction disturbed area and the hard site, which is difficult to restore vegetation in the later period, and it is easy to cause major soil and water loss. Improper selection of disposal points of residual soil leads to obvious soil and water loss, such as slope slagging. Therefore, the third objective of construction disturbance prevention and control is to ensure that the quantity and quality of stripped topsoil resources are not reduced by clarifying the pile location and maintenance and protection measures after topsoil stripping. At the same time, according to the terrain conditions of the construction area, appropriate disposal methods and improved protection measures were selected to meet the requirements of topsoil stripping and disposal of residual soil, and effectively improve the connection with plant measures, reduce the difficulty of vegetation restoration, and save construction costs. ［9-11］

2.2 Corresponding measures modular design

In the construction of power grid engineering, we adopt the strategy of modular design in order to better cope with the construction challenges under different terrain conditions. The modular

design is mainly divided into two key parts: construction road construction and base area work platform construction.

In the road construction module, first of all, in the flat area, we carried out a detailed assessment of the bearing capacity of the road surface, and took reinforcement measures according to the need. In the face of continuous rainfall and other effects, we use roadbed boxes, steel plates or gravel for road reinforcement, while preserving the image data of the original pavement for future reference. In paddy fields and lakes, we avoided the breeding season of shrimp ponds and the rainy season, and used technology such as roadbed boxes and culvert pipes to ensure that construction would not cause damage to the surrounding environment. For temporary roads in paddy fields, we remove silt and build them with subgrade boxes or steel plates, ensuring smooth drainage.

In the construction module of the operation platform in the base area, in the paddy field and the lake area, we adopted the way of laying the subgrade box or steel plate directly, while the residual soil was properly treated to ensure that the safety of the tower legs was not affected. During the construction of the pile foundation, we set up a mud pond and a settling pond to treat the drilling slurry. In the mountainous area, we are divided into different cases according to the slope of the terrain, and adopt the strategy of digging while carrying out, tamping, etc., to ensure the stability and safety of the construction. As for the residual soil in the base, we stacked it flat or piled it into a turtle back type, fixed it with vegetation bags, and carried out vegetation restoration after the construction.

This modular design not only improves the efficiency of construction, but also minimizes the impact on the surrounding ecological environment to ensure the smooth progress of the power grid project.

2.3 Research on environmental protection and soil and water conservation measures

(1) Early design control of topsoil and residual soil

Taking the P214 tower of Yancheng-Chenzhou East 500kV line project as an example, the original topographic DEM map and remote sensing image map of P214 tower were obtained by UAV flight, combined with soil and water conservation construction drawing, basic configuration table and other data, and the investigation results of on-site mechanized construction were analyzed in detail. The design diagram of topsoil and residual soil disposal at the excavation and levelling stage of the foundation is preliminarily formed.

Specifically, it includes the following contents: select the gentle slope or flat road along the contour line to construct the temporary road, strictly control the road width and base height, and reserve enough turning radius at the road bend; In the process of excavation, the topsoil should be stripped and stacked, and the excavation at the steep slope should be carried out through the low area of the backfill road. Two construction platforms are set up to minimize the disturbance range of construction in the control base area and clarify the construction limit. The base area should set up residual soil stacking areas around the disturbed areas according to the terrain, and the construction road area should reserve residual soil stacking areas on the outer slope of the road, so as to specify the stacking height, width and cover measures to prevent soil erosion in the residual soil during the construction process. A topsoil stacking area is set up on the gentle slope of the base area, and the requirements for the height limit and cover of the pile are defined to ensure that the topsoil resources are not lost. The requirements of temporary blocking measures are defined at the low tower legs to ensure that no sliding slag occurs at the tower legs.

(2) Top soil and residual soil construction process control

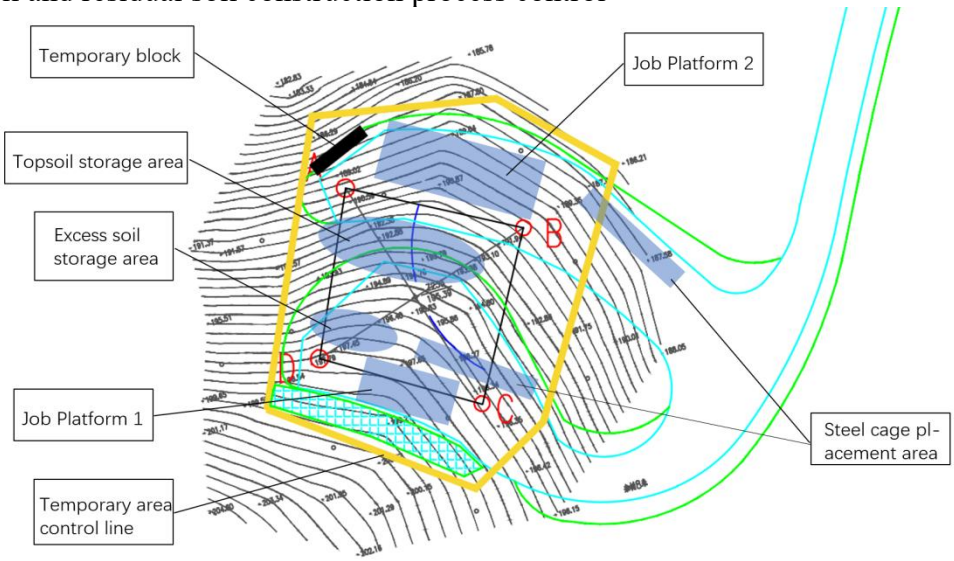

FIG. 2 P214 tower foundation excavation and site leveling stage topsoil and residual soil disposal design diagram

The mechanized excavation construction is adopted to strictly control the road width and control the base reduction height (1.5m) by selecting relatively gentle excavation and appropriately increasing the slope of the climbing road, so as to reduce the amount of excavated soil backfill. The disturbance area of road construction is controlled within 600㎡ , the width of the road is controlled within 4m, the length is controlled within 150m, the slope of the climbing road is controlled at 15°, and the local slope is controlled at 25° (the length is controlled within 30m); It is prohibited to use more than 8 cubic meters of tank truck transport and other materials. All the residual soil of the partial foundation reduction section is transferred to the relatively gentle road cushion treatment.

Excavators are only used to peel off slopes with slopes less than 35 degrees. In the process of half-digging and half-filling of the construction road, the topsoil on the front slope will be peeled off and piled up, and then the excavators will move the topsoil to the side of the road behind the fuselage for stacking through the digging arm. The stacking width will be controlled by about 1 meter, and the stacking will be placed on the side of the road slope with a width of 1m and a height of 0.5-0.7m. Mountain slopes less than 25 degrees, and the base height is less than 1.2 meters, directly stacked in the front of the road to be excavated on the upper hillside; The mechanical stripping speed can reach 5~10m³/h, the traditional stripping speed is 0.2~0.5m³/h/ person, the cost and working hours compared with the traditional extensive construction, the economic comparison is 2~3 times. Due to the steep slope, the road longitudinal slope is large, easy to appear soil and water loss, the need for interception control, 15-20 meters apart to set a lateral interception ditch, the interior can lay gravel to facilitate the passage of vehicles, and in the road to set up drainage ditch, timely drainage. To cover the slopes formed by excavation in time, vegetation restoration can be carried out in advance in combination with seeding grass seeds. ［12-13］

The single-stage platform area of the excavation platform is controlled within 200 square meters, the width of the operation platform is about 4-6 meters, to ensure the accessibility of the rotary drilling rig, and the local lateral slope can be widened and placed in the steel cage. The base reduction should be controlled within 2 meters as far as possible, and the earth and rock should be absorbed as much as possible by half-digging and half-filling. The backfill external slope with the original terrain slope exceeding 35 degrees should be blocked by passive net or bamboo and wood

fence, and the height difference of the block relative to the working platform base should be controlled within 2m to prevent slag walking. Excessive residual soil can be transferred to the gentle pavement of the road for bedding, or it can be temporarily stacked on the side of the excavation slope of the working platform with a large area to reduce the slope of the excavation slope.

Similar to the temporary road topsoil stripping and stacking methods, mainly stacked in the uphill position, but the stripped topsoil can also be piled at the edge of the platform by planting bags or bamboo fence temporary blocking way. During the operation of rotary drilling rig, the tower leg on the far side of the construction road is given priority. The excavated residual soil is temporarily stacked on the inside edge of the operation platform, 2m away from the foundation pit, and transferred to the gentle area of the road in time, and the residual soil is disposed of by the thickening road. The original slope of the working platform is relatively gentle, can be stacked at the edge of the platform, excavator leveling and compaction disposal.

The slopes formed by excavation should be covered in time, which can be combined with seeding grass seeds to carry out vegetation restoration in advance. Due to the inability to use commercial mixing tank trucks for construction, according to the planning and actual construction site conditions, the mixing area is set up in the third operation platform on the site, and the cement, sand and stone materials used are piled in the third platform on the uphill position and poured through the chute. If the chute is not easy to operate, it shall be transferred to the middle of the lowest platform for mixing and construction with mixing. When mixing, pay attention to the isolation of the working floor. For the base platform, the drainage ditch is excavated inside the slope, and the drainage ditch is dug around each tower leg to prevent the influence of mud water on the pouring. ［14-15］

3. Result analysis

Considering the current mechanized construction of China's power grid project, the project construction has a great impact on the local ecological environment. Therefore, we actively adopt the technical process of improving environmental protection and soil and water conservation, do a good job of environmental protection and water conservancy publicity work before the construction of the project, and increase the inspection and evaluation during the construction process. Give full play to the advantages of mechanized construction to achieve the ultimate purpose of temporary construction and protection of ecological environment. Taking P214 Tower of Yancheng-Chenzhou East 500kV line project in Hunan area as an example, the detailed implementation of soil and water conservation measures in the whole process meets the requirements of safety and reliability, independent innovation, economic rationality, environmental protection and world-class construction. The construction enterprises mainly start from the following aspects and put forward clear requirements: First, the foundation excavation and the disposal of topsoil and residual soil at the levelling stage. The second is to organize and arrange more professional and innovative soil and water conservation industry talents to participate in the environmental protection and water protection work of the mechanized construction of the power grid project, make full use of modern mechanical technology and ecological environmental protection concepts, give priority to the selection of sites that meet the construction and environmental protection requirements for construction management, and truly play the application value of the modular design concept. Third, in order to further improve the level of smart grid project construction, China's Ministry of Infrastructure in the whole process of construction mechanization, strengthen the line design, technical equipment, construction management and other aspects of innovation, from the original labor-intensive construction mode to technology-intensive

and equipment-intensive, which can not only improve the efficiency of on-site construction, It can also fundamentally ensure the quality of power grid projects.

Conclusion

To sum up, in the process of mechanized construction of power grid engineering, comprehensive consideration of construction costs and the impact of construction on environmental protection and soil and water conservation, the full implementation of the modular design concept, shorten the construction period, control construction costs, and reduce construction risks can not only meet the needs of the new era of power grid construction management, but also fully demonstrate the application value of the modular design concept. Provide technical support for creating high-quality social environment and power resources. Therefore, future scholars should continue to explore the environmental protection and water and soil conservation technologies of the mechanized construction of power grid engineering based on modular design, clarify the application value of the modular design concept, and actively introduce excellent technical talents to reduce the safety risks of the mechanized construction of power grid engineering.

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